incapable of consciousness), evoke movements appropriate for escape from or removal of the stimulus applied. Now "feeling" is implicit in the emotional state; the state is an "affective state." In the evolution of emotion the revival of "feelings" pleasurable and painful must have played a large part. Hence the close relation of emotion with sense organs that can initiate bodily pain or pleasure, and hence its connection with impulsive or instinctive movement. There is no wide interval between the reflex movement of the spinal dog, whose foot attempts to scratch away an irritant applied to its back—both leg and back absolutely detached from consciousness—and the reaction of the decerebrate dog that turns and growls and bites at the fingers holding his hind foot too roughly. In the ormer case the motor reaction occurs, although the mind is not even aware of the stimulus, far less percipient of it as an irritant. The action occurs, and plays the pantomime of feeling; but no feeling comes to pass. In the latter case the motor reaction occurs, and is expressive of emotion; but it is probably the reaction of an organic machine, which can be started working, though the mutilation precludes the psychosis of emotion.

And with the gesture and the attitude will occur the visceral concomitant. It would be consonant with what we know of reflex action if the spur that started the muscular expression should simultaneously and of itself initiate, also, the visceral adjunct reaction. It is almost impossible to believe that with the mere stump of brain that remained to Goltz's dog there could be any elaboration of a percept. All trace of memory was lacking to the creature. Yet though not evincing other emotion, anger it showed as far as expression can yield revelation. Fear, joy, affection seem, therefore, in the observation of this skilled observer of animal mind, to demand higher nervous organisation than does anger. Be that as it may, the retention of its expression by Goltz's dog indicates that by "retrogradation" the complex movement of expression has in certain emotions passed into a simple reflex act. When the habituating practice of acts is carried far the determining motives finally become, even in impulsive acts, weaker and more transient. The external stimulus originally aroused a strongly affective group of ideas, which operated as a motive, but now it causes a discharge of the act before it can be apprehended as an idea. The impulsive movement of a "lower," "coarser," so-called "animal" emotion, has in this case become an automatic reflex process no longer necessarily combined with the psychical state whence it arose, of which it is normally at once the adjunct and the symbol. C. S. SHERRINGTON.

THE CENTENARY OF THE ROYAL COLLEGE OF SURGEONS.

MR. VICTOR PLARR'S article, in last week's NATURE, on the celebration of the centenary of the Royal College of Surgeons of England contained a brief statement of the ceremonies which were to commence on the day we went to press. The proceedings were opened on Wednesday morning, July 25, when demonstrations were given in the Hunterian Museum of the College by the conservator, Prof. C. Stewart, F.R.S., who conducted visitors round the galleries, pointing out and describing some of the more important and interesting specimens. At the same time, in the theatre of the Examination Hall, Dr. T. G. Brodie, director of the laboratories of the Conjoint Board, gave an account of some of the work recently carried out in the research laboratories. In the evening a conversazione was held at the College, and was attended by many distinguished guests. Demonstrations were again given by Prof. Stewart and Dr. Brodie on Thursday morning; and in the afternoon, Sir William MacCormack, the president, delivered an address of welcome, and presented the diploma of Honorary Fellow to the Marquis of Salisbury and the Earl of Rosebery. As already stated (p. 294), the Prince of Wales received the diploma on July 24; and the form of the Royal diploma is the same as that employed for all the Honorary Fellowships.

The following is the list of other Honorary Fellows to whom diplomas were presented on Thursday:—E. Albert, professor of clinical surgery, University of Vienna; C. B. Ball, Regius professor of surgery, University of Dublin; E. Bassini, professor of clinical surgery, Royal University of Padua; E. H. Bennett, professor of surgery, Trinity College, Dublin; J. W. Berg, professor of surgery, Royal Caroline Institute of Medicine and Surgery, Stockholm; Prof. von Bergmann, Berlin; O. Bloch, professor of surgery, University of Copenhagen; E. Bottini, professor of clinical surgery, Royal University of Pavia; I. H. Cameron, professor of clinical surgery, University of Toronto; Dr. Salvador Cardenal Fernandez, vice-president, Royal Academy of Medicine and Surgery, Barcelona; Antonino D'Antona, professor of surgery, Royal University of Naples; Francesco Durante, professor of clinical surgery, Royal University of Rome; Prof. Dr. Friedrich von Esmarch, Kiel; W. S. Halsted, professor of surgery, Johns Hopkins University, Baltimore; Hon. Sir W. H. Hingston, professor of clinical surgery, University of Laval; Surgeon-General James Jameson, C.B., Director-General, Army Medical Service; W. W. Keen, professor of the principles of surgery and of clinical surgery, Jefferson Medical College, Philadelphia; Theodor Kocher, professor of surgery, University of Bern; Prof. Dr. Franz König, Berlin; Prof. Kosinskij, professor of surgery in the University of Warsaw; Prof. Dr. E. G. F. Küster, Marburg; Elie Lambotte, Brussels; Odilon Marc Lannelongue, professor of surgical pathology, Faculty of Medicine of Paris; Karl Gustaf Lennander, professor of surgery and obstetrics, University of Upsala; W. Macewen, F.R.S., Regius professor of surgery, University of Glasgow; Colonel Kenneth MacLeod, professor of clinical and military medicine, Army Medical School, Netley; Julius Nicolaysen, professor of surgery, Royal University of Christiania; Sir Henry Frederick Norbury, K.C.B., Director-General, Medical Department of the Royal Navy; Leopold Ollier, professor of clinical surgery, University of Lyons; Victor Pachoutine, president, Imperial Military Academy of Medicine, St. Petersburg; Samuel Pozzi, professor in the Faculty of Medicine of Paris; Colonel D. C. O'Connell Raye, Indian Medical Service; T. G. Roddick, professor of surgery, McGill University, Montreal; Federico Rubio y Gali, member of the Royal Academy of Medicine of Madrid; Nicolas Wassilievitch Sklifossovsky, director and Emeritus professor, Imperial Clinical Institute of the Grand Duchess Helena Pavlovna, St. Petersburg; Paul Tillaux, professor of clinical surgery, Faculty of Medicine of Paris; Nicolas Veliaminoff, professor of surgery, Imperial Military Academy of Medicine, St. Petersburg; John Collins Warren, professor of surgery, Harvard University; Robert Fulton Weir, professor of clinical surgery, Columbia University, New York. After the presentation brief addresses of thanks were delivered by Prof. v. Bergmann of Berlin, Prof. Durante of Rome, Dr. W. W. Keen of Philadelphia, Prof. Lannelongue, and Dr. T. G. Roddick of Montreal.

FACTS OF INHERITANCE.[1]

ONE of the distinctive features of the nineteenth century has been a reduction in the number of supposed separate powers or entities—the use of William of Occam's razor, in fact. In view of this progress towards greater precision of phraseology, it cannot be a matter for surprise that a biologist should affirm that to speak of the "Principle of Heredity" in organisms is like speaking of the "Principle of Horology" in clocks. For heredity is certainly no power or force, or principle, but a convenient term for the relation of organic or genetic continuity which binds generation to generation.

Another distinctive feature in scientific progress has been the introduction of precise measurement. In the development of natural knowledge, science begins where measurement begins. This is the case in regard to inheritance. While nothing can take the place of experiment, much has been gained by the application of statistical and mathematical methods to biological results—a new contact between different disciplines—which we may particularly associate with the names of Mr. Francis Galton and Mr. Karl Pearson.

I. THE PHYSICAL BASIS OF INHERITANCE.

What was for so long quite hidden from inquiring minds, or but dimly discerned by a few, is now one of the most marvellous of biological commonplaces—that the individual life of the great majority of plants and animals begins in the union of two minute elements—the sperm-cell and the egg-cell. If inheritance includes all that the living creature is or has to start with in virtue of its genetic relation to its parents and ancestors, then it is

[1] Abridged from a discourse delivered at the Royal Institution on Friday, March 30, by Prof. J. Arthur Thomson, F.R.S.

plain that the physical basis of inheritance is in the fertilised ovum. As regards property, there is an obvious distinction between the inheritance and the person who inherits, but there is no such distinction in biology. The fertilised egg-cell *is* the inheritance, and is at the same time the potential inheritor.

An organic inheritance means so much, even when we use the magic word potentiality, that we may consider for a moment the difficulty which rises in the minds of many when they remember that the egg-cell is often microscopic, and the sperm-cell often only 1/100,000th of the ovum's size. Can there be room, so to speak, in these minute elements for the complexity of organisation supposed to be requisite? The difficulty will be increased if the current opinion be accepted that only the nuclei within the germ-cells are the true bearers of the hereditary qualities.

In reference to this difficulty, it may be recalled that the students of physics tell us that the image of a *Great Eastern* filled with framework as intricate as that of the daintiest watches does not exaggerate the possibilities of molecular complexity in a spermatozoon, whose actual size may be less than the smallest dot on the watch's face. Secondly, as we learn from embryology that one step conditions the next and that one structure grows out of another, we are not forced to stock the microscopic germ-cells with more than initiatives. Thirdly, we must remember that the development implies an interaction between the growing organism and a complex environment without which the inheritance would remain unexpressed, and that the full-grown organism includes much that was not inherited at all, but has been acquired as the result of nurture or external influence.

The central problem of heredity is to form some conception of what we have called the relation of genetic continuity between successive generations; the central problem of inheritance is to measure the resemblances and differences in the hereditary characters of successive generations, and to arrive, if possible, at some formula which will sum up the facts. Therefore, while it is interesting to ask how an organisation supposed to be very complex may be imagined to find physical basis in a microscopic germ-cell, the same sort of question may be raised in regard to a ganglion-cell. It is not distinctively a problem of heredity. Similarly, while it is interesting to inquire into the orderly and correlated succession of events by which the fertilised egg-cell gives rise to an embryo, this is the unsolved problem of physiological embryology.

In the preformationist theories, which asserted the pre-existence of the organism and all its parts, in miniature, within the germ—there was a kernel of truth well concealed within a thick husk of error. For we may still say that the future organism is implicit in the germ, and that the germ contains not only the rudiment of the adult organism, but the potentiality of successive generations as well. But what baffled the earlier investigators was the question how the germ-cell comes to have this ready-made organisation, this marvellous potentiality.

An attempt to solve this difficulty of accounting for the complex organisation presumed to exist in the germ-cell is expressed in a theory which occurred at intervals in the long period between Democritus and Darwin, the theory of pangenesis. On this theory, the cells of the body are supposed to give off characteristic and representative gemmules; these are supposed to find their way to the reproductive elements, which thus come to contain concentrated samples of the different components of the body, and are, therefore, able to develop into an offspring like the parent. The theory involves many hypotheses, and is avowedly unverifiable in direct sense-experience, but it is more to the point to notice that there is another theory of heredity which is, on the whole, simpler, which seems, on the whole, to fit the facts better, especially the fact that our experience does not warrant the conclusion that the modifications or acquired characters of the body of the parent affect in any specific and representative way the inheritance of the offspring.

As is well known, the view which most biologists now take of the uniqueness of the germ-cells is expressed in the phrase "germinal continuity." There is a sense, as Mr. Galton says, in which the child is as old as the parent, for when the parent's body is developing from the fertilised ovum, a residue of unaltered germinal material is kept apart to form the future reproductive cells, one of which may become the starting-point of a child. In many cases, from worms to fishes, the beginning of the lineage of germ-cells is demonstrable in very early stages before the differentiation of the body-cells has more than begun. In the development of the threadworm of the horse, according to Boveri, the very first cleavage divides the fertilised ovum into two cells, one of which is the ancestor of all the body-cells, and the other the ancestor of all the germ-cells. In other cases, particularly among plants, the segregation of germ-cells is not demonstrable until a relatively late stage. Weismann, generalising from cases where it seems to be visibly demonstrable, maintains that in all cases the germinal material which starts an offspring owes its virtue to being materially continuous with the germinal material from which the parent or parents arose. But it is not on a continuous lineage of recognisable germ-*cells* that Weismann insists, for this is often unrecognisable, but on the continuity of the germ-*plasm*—that is, of a specific substance of definite chemical and molecular structure which is the bearer of the hereditary qualities. In development, a part of the germ-plasm, "contained in the parent egg-cell is not used up in the construction of the body of the offspring, but is reserved unchanged for the formation of the germ-cells of the following generation." Thus the parent is rather the trustee of the germ-plasm than the producer of the child. In a new sense, the child is a chip of the old block. The conception of a germ-plasm is hypothetical, just as the conception of a specific living stuff or protoplasm is hypothetical. In the complex microcosm of the cell, we cannot point to any one stuff and say, "this is protoplasm"; it may well be that vital activity depends upon several complex stuffs which, like the members of a carefully constituted firm, are characteristically powerful only in their inter-relations. In the same way, we cannot demonstrate the germ-plasm, even if we may assume that it has its physical basis in the stainable nuclear bodies or chromosomes. The theory has to be judged, like all conceptual formulæ, by its adequacy in fitting facts.

II. Dual Nature of Inheritance.

Apart from exceptional cases, the inheritance of a multicellular animal or plant is dual, part of it comes from the mother and part of it from the father.

Prof. E. B. Wilson states the general opinion of experts somewhat as follows:—As the ovum is much the larger, it is believed to furnish the initial capital—including it may be a legacy of food-yolk—for the early development of the embryo. From both parents alike comes the inherited organisation which has its seat (according to many) in the readily stainable (chromatin) rods of the nuclei. From the father comes a little body (the centrosome) which organises the machinery of division by which the egg splits up, and distributes the dual inheritance equally between the daughter-cells.

Recent researches confirm a prophecy which Huxley made in 1878: "It is conceivable, and indeed probable, that every part of the adult contains molecules derived both from the male and from the female parent; and that, regarded as a mass of molecules, the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male." "What has since been gained," Prof. Wilson says, "is the knowledge that this web is to be sought in the chromatic substance of the nuclei, and that the centrosome is the weaver at the loom."

In regard to these conclusions, three notes are necessary. (*a*) Although inheritance is dual, it is in quite as real a sense multiple, from ancestors through parents. (*b*) If Loeb is able to induce artificial parthenogenesis in sea-urchins' eggs exposed for a couple of hours to sea-water to which some magnesium chloride has been added; if Delage is able to fertilise and to rear normal larvæ from non-nucleated ovum-fragments of sea-urchin, worm and mollusc, we should be chary of committing ourselves definitely to the conclusion that the nuclei are the exclusive bearers of the hereditary qualities, or that both must be present in all cases. Furthermore, the fact that an ovum without any sperm-nucleus, or an ovum-fragment without any but a sperm-nucleus, can develop into a normal larva points to the conclusion, probable also on other grounds, that each germ-cell, whether ovum or spermatozoon, bears a complete equipment of hereditary qualities. (*c*) It must be carefully observed that our second fact does not imply that the dual nature of inheritance must be patent in the full-grown offspring, for hereditary resemblance is often strangely unilateral, the characters of one parent being "prepotent," as we say, over those of another.

III. Different Degrees of Hereditary Resemblance.

One step of progress during the Darwinian era has been the recognition of inheritance as a fact of life which requires no further proof.

Yet this aspect of the study of heredity is by no means worked

out. Thus there are some characters, *e.g.* tendency to certain diseased conditions, which are more frequently transmitted than others, and we ought to have, in each case, precise statistics as to the probabilities of transmission.

Again, there are some subtle qualities whose heritability must not be assumed without evidence. Thus it is of very great importance to students of organic evolution that Prof. Karl Pearson has recently supplied, for certain cases, definite proof of the inheritance of fecundity, fertility and longevity.

The familiar saying, "like begets like," should rather read, "like tends to beget like," since variation is quite as important a fact as complete hereditary resemblance. If it seems that in many cases the offspring is practically a facsimile reproduction of the parent, this may be due to absence of variation, or, what comes almost to the same thing, to great completeness of inheritance; but it is more likely to be due to our ignorance, to our inability to detect the idiosyncrasies.

But it will be granted that the completeness with which the characters of race, genus, species and stock are reproduced generation after generation is one of the large facts of inheritance. But this does not sum up our experience, and we must face the task of considering the different degrees of hereditary resemblance. For these a confused classification and a troublesome terminology has been suggested, but it will be enough to restrict attention to three familiar cases—blended, exclusive and particulate inheritance.

A preliminary consideration must be attended to. It is a matter of observation that there are great differences in the degree in which offspring resemble their parents; but it is surely a matter of conjecture that lack of resemblance is necessarily due to incompleteness in the inheritance. Indeed, the fact that the resemblance so often reappears in the third generation makes it probable that the incompleteness is not in the inheritance, but simply in its expression. The characters which seem to be absent, to "skip a generation," as we say, are probably part of the inheritance, as usual. But they remain latent, neutralised, silenced (we can only use metaphors) by other characters, or else unexpressed because of the absence of the appropriate stimulus.

(*a*) In *blended* inheritance, the characters of the two parents, *e.g.* in regard to a particular structure, such as the colour of the hair, may be intimately combined in the offspring. This is particularly well seen in some hybrids, where the offspring often seems like the mean of the two parents; it is probably the most frequent mode of inheritance.

(*b*) In *exclusive* inheritance, the expression of maternal or of paternal characters in relation to a given structure, such as eye-colour, is suppressed. Sometimes the unilateral resemblance is very pronounced, and we say that the boy is "the very image of his father," or the daughter "her mother over again"; though even more frequently the resemblance seems "crossed," the son taking after the mother, and the daughter after the father.

(*c*) It is convenient to have a third category for cases where there is neither blending nor exclusiveness, but where in the expression of a given character, part is wholly paternal and part wholly maternal. This is called *particulate* inheritance. Thus, an English sheep-dog may have a paternal eye on one side, and a maternal eye on the other. Suppose the parents of a foal to be markedly light and dark in colour; if the foal is light brown the inheritance in that respect is blended, if light or dark it is exclusive, if piebald it is particulate. In the last case there is in the same character an exclusive inheritance from both parents.

The facts above referred to may be considered in another aspect, in terms of what is called the quality of prepotency. In the development of a character the paternal or the maternal qualities may predominate, as in unequal blending where there is relative prepotency, or in exclusive inheritance where the prepotency in respect to a given character is absolute. It seems doubtful whether we gain much by using the word, since all these general terms are apt to form the dust particles of intellectual fog; but we have to do with the fact that in respect to certain characters the paternal inheritance seems more potent than the maternal, or *vice versa*.

It seems that one of the ways in which the quality of prepotency may be developed is by inbreeding, as Prof. Ewart and others have maintained.

Therefore, as inbreeding may be frequent in nature, especially in gregarious and isolated groups, and as it tends to develop prepotency, we are able to understand better how new variations may have been fixed in the course of evolution. And we can appreciate the position maintained by Reibmayr, that the evolution of a human race implies alternating periods of dominant inbreeding, and dominant cross-breeding. The inbreeding gives fixity to character, the cross-breeding averts degeneracy and stimulates new variations which form the raw material of progress.

Until we have more precise statistical data in regard to blended, exclusive and particulate inheritance, we cannot hope to simplify the matter with any security. But perhaps a unified view will be found in the theoretical conception of a germinal struggle in the arcana of the fertilised ovum, a struggle in which the maternal and paternal contributions may blend and harmonise, or may neutralise one another, or in which one may conquer the other, or in which both may persist without combining. We have extended the wide conception of the struggle for existence in many directions; it may be between organisms akin or not akin, between plants and animals, between organisms and their inanimate environment, between the sexes, between the different parts of the body, between the ova, between the spermatozoa, between the ova and the spermatozoa, and Weismann has suggested that it may also be between the constituents of the germ-plasm.

IV. REGRESSION.

We have already referred to the fact that there is a sensible stability of type from generation to generation. "The large," Mr. Galton says, "do not always beget the large, nor the small the small; but yet the observed proportion between the large and the small, in each degree of size and in every quality, hardly varies from one generation to another." In other words, there is a tendency to keep up a specific average. This may be partly due to the action of natural elimination, weeding out abnormalities, often before they are born. But it is to be primarily accounted for by what Mr. Galton calls the fact of "filial regression."

As Mr. Galton puts it, society moves as a vast fraternity. The sustaining of the specific average is certainly not due to each individual leaving his like behind him, for we all know that this is not the case. It is due to a regression which tends to bring the offspring of extraordinary parents nearer the average of the stock. In other words, children tend to differ less from mediocrity than their parents.

This big average fact is to be accounted in terms of that genetic continuity which makes an inheritance not dual, but multiple. "A man," says Mr. Pearson, "is not only the product of his father, but of all his past ancestry, and unless very careful selection has taken place, the mean of that ancestry is probably not far from that of the general population. In the tenth generation a man has [theoretically] 1024 tenth great-grandparents. He is eventually the product of a population of this size, and their mean can hardly differ from that of the general population."

At this point one should discuss reversion or atavism, but it is exceedingly difficult to get a firm basis of fact. The term reversion includes cases where *through inheritance* there reappears in an individual some character which was not expressed in his parents, but which did occur in an ancestor. The character whose reappearance is called a reversion may be found within the verifiable family, within the breed, within the species, or even in a presumed ancestral species.[1]

The best illustrations of reversion are furnished by hybrids. Thus in one of Prof. Cossar Ewart's experiments a pure white fantail cock pigeon, of old-established breed, which in colour had proved itself prepotent over a blue pouter, was mated with a cross previously made between an owl and an archangel, which was far more of an owl than an archangel. The result was a couple of fantail-owl-archangel crosses, one resembling the Shetland rock-pigeon, and the other the blue rock of India.

But great carefulness is necessary in arguing from the results of hybridisation to those of ordinary mating, and even if some of the phenomena of exclusive inheritance seem to show reversion

[1] Prof. Karl Pearson defines a *reversion* as "the full reappearance in an individual of a character which is recorded to have occurred in a *definite* ancestor of the same race," and *atavism* as "a return of an individual to a character not typical of the race at all, but found in allied races supposed to be related to the evolutionary ancestry of the given race." "In reversion we are considering a variation, normal or abnormal, from the standpoint of *heredity in the individual;* in atavism we are considering an abnormal variation from the standpoint of the *ancestry of the race.*" But the two words seem to be used by some authors in the converse way, or as equivalent, and it is surely difficult to define the field of abnormal variation.

to a near ancestor we need a broader basis of fact than we have at present before we can formulate any law. The recorded cases show that many phenomena are labelled reversions on the flimsiest evidence. Thus the occurrence of a Cyclopean human monster with a median eye has been called a reversion to the sea-squirt, and gout has been called a reversion to the reptilian condition of liver and kidneys. Often there is not the slightest attempt to discriminate between true reversion (*i.e.* the re-expression of latent ancestral characters) and the phenomena of arrested development, or of abnormalities which have been induced from without. Often, too, there has been no scruple in naming or inventing the ancestor to whom the reversion is supposed to occur, although evidence of the pedigree is awanting; and the vicious circle is not unknown of arguing to the supposed ancestor from the supposed reversion, and then justifying the term reversion from its resemblance to the supposed ancestor. Little allowance has been made for coincidence, and the postulate of characters remaining latent for millions of years is made as glibly as if it were just as conceivable as a throw-back to a great-grandfather.

There seems no way out of the theory that characters may lie latent for a generation or for generations, or in other words that certain potentialities or initiatives which form part of the heritage may remain unexpressed for lack of the appropriate liberating stimulus, or for other reasons, or may have their normal expression disguised. But it does not follow that the reappearance of an ancestral character not seen in the parents is necessarily due to the reassertion of latent elements in the inheritance. It may be a case of ordinary regression; it may be a case of arrested development; it may be an extreme variation whose resemblance to an ancestral characteristic is a coincidence; it may be an individually acquired modification, reproduced apart from inheritance, by a recurrence of suitable external conditions, and so on. What are called reversions are probably in many cases misinterpretations.

V. Galton's Law.

The most important general conclusion which has yet been reached in regard to inheritance is formulated in Galton's Law. Mr. Galton was led to it by his studies on the inheritance of human qualities, and more particularly by a series of studies on Basset hounds. It is one of those general conclusions which have been reached statistically, and I must refer for the evidence and also for its strictest formulation to the revised edition of Mr. Pearson's "Grammar of Science."[1]

As we have seen, it is useful to speak of a heritage as dual, half derived from the father and half from the mother. But the heritable material handed on from each parent was also dual, being derived from the grandparents. And so on, backwards. We thus reach the idea that a heritage is not merely dual, but in a deeper sense multiple.

To appreciate the possible complexity of our mosaic inheritance we must recall the number of our ancestors. We have two parents, four grandparents, eight great-grandparents, about sixteen great-great-grandparents, and so on. But as we go backwards the theoretical number far exceeds the reality; a reduction in the number of ancestors is brought about by inter-marriage, as this table (from Lorenz) in reference to Kaiser Wilhelm II. clearly shows.

Genarations.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
(1) Theoretical Number.	2	4	8	16	32	64	128	256	512	1024	2048	4096
(2) Actual number known.	2	4	8	14	24	44	74	111	162	206	225	275
(3) Inadequately known.								5	15	50	117	258
(4) Probable total.								116	177	256	342	533

According to Galton's Law, "the two parents between them contribute *on the average* one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter, or each of them one-sixteenth; and so on, the sum of the series, $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$&c., being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow: thus $\frac{1}{2}=\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$&c.; $\frac{1}{4}=\frac{1}{8}+\frac{1}{16}+$&c., and so on. The prepotencies or subpotencies of particular ancestors, in any given pedigree, are eliminated by a law that deals only with *average* contributions, and the varying prepotencies of sex in respect to different qualities are also presumably eliminated."

The aim of this lecture has been to present in brief compass a statement of the leading facts of inheritance, which should be clear in the minds of all. Nothing has been said in regard to the transmissibility of acquired characters, for this cannot be ranked at present as an established fact, and some other doubtful points have been left unmentioned. The study of inheritance leaves a fatalistic—almost paralysing—impression on many minds, especially perhaps if it be believed that the acquired results of experience and education—of "nurture," in short, cannot be entailed upon the offspring. To some extent this fatalistic impression is justified, but it is well that it should rest upon a sound basis of fact and not on exaggerations. In a sense we can never get away from our inheritance. As Heine said half bitterly, half laughingly, "A man should be very careful in the selection of his parents." On the other hand, although the human organism changes slowly in its heritable organisation, it is very modifiable individually, and "nature" can be bettered by "nurture." If there is little scientific warrant for our being other than sceptical at present as to the inheritance of acquired characters, this scepticism lends greater importance than ever, on the one hand, to a good "nature," to secure which for offspring is part of the problem of careful mating; and, on the other hand, to a good "nurture," to secure which for our children and children's children is one of the most obvious of duties, the hopefulness of the task resting upon the fact that, unlike the beasts that perish, man has a lasting external heritage, capable of endless modification for the better.

[1] Reference should, however, be made to Mr. Pearson's recent paper *Proc. Roy. Soc.*, lxvi. 1900, pp. 140–164) on the law of reversion.

University and Educational Intelligence.

Mr. A. Rendle Short, of University College, Bristol, has been awarded the gold medal and exhibition in physiology, the gold medal and exhibition in materia medica, and first-class honours in anatomy, upon the results of the recent Intermediate M.B. examination of the University of London. The exhibitions in physiology and materia medica are of the value of 80*l.* and 60*l.*

A discussion on the teaching of geography will be held at Cambridge on Friday, August 24, under the auspices of the Geographical Association, and in connection with the Summer Meeting. Prof. W. M. Davis, of Harvard University, will occupy the chair, and among the subjects to be brought before the Association are class excursions, map drawing, the use of the globe, geography in the grammar school, and possibilities and limitations of geography in a day school. There are several exhibits of interest to teachers of geography in the education exhibition, arranged in connection with the Summer Meeting.

Lord Bute has offered the University of St. Andrews a sum of 20,000*l.*, to be held as a fund for endowing a chair of anatomy, upon the following conditions:—(1) That the said sum of 20,000*l.* shall be paid to the University not later than ten years hence. The exact date cannot be specified, as it will depend upon completion of certain works at Cardiff. Interest at 3 per cent. will be payable to the University from the time of the appointment of the first professor until they receive the principal sum; (2) that the first presentation to the chair shall be in favour of Mr. Musgrove, the present holder of the lectureship in anatomy in St. Andrews; (3) that the lectures shall be given exclusively in St. Andrews; (4) that the course shall meet the requirements of the two first *Anni Medici*; and (5) that before the beginning of the University session, 1901–1902, the approval of the Universities Committee of the Privy Council to the establishment of the chair under the foregoing conditions be obtained, and that the approval of Lord Bute or his representatives be obtained to any further conditions embodied in the ordinance instituting the chair.

The relations between scientific work and industrial progress have been so often described in these columns that there is little new to be said upon the subject. But though readers of Nature may be familiar with many instances of the close connection between science and industry, it will be a long time before the knowledge filters down to the general public and starts a reaction in commercial and manufacturing circles. Every man of science who takes advantage of an opportunity to impress the value of scientific observation and research upon the minds of citizens